NISTTech

Superconformal Film Growth

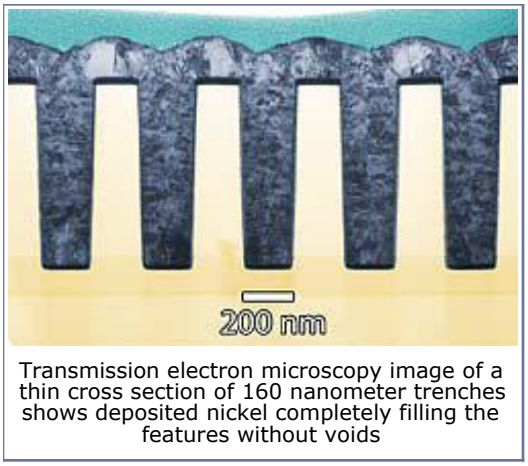
Void-free 3D metallized structures through Damascene metallization

Description

This invention is a deposition process that allows void-free filling of recessed features on non-planar metallized surfaces with nickel and related iron group alloys. The process could enable whole new classes of sensors and microelectromechanical (MEMS) devices. The method is a variation of a technique called "Damascene metallization" that often is used to create complicated 3-D copper interconnections, the "wiring" that links circuit elements across multiple layers in advanced, large-scale integrated circuits. The challenge in Damascene metallization is ensuring that the deposited metal completely fills in the deep, narrow trenches without leaving voids. NIST scientists designed the void-free 3-D metal structures by adding a chemical to the electrodeposition solution to prevent the metal from building up too quickly on the sides of the trenches and by carefully controlling the deposition process.

NOTE; see NIST Docket 02-011, U.S. Patent #7,429,401 under Citations below.

Images



Transmission electron microscopy image of a thin cross section of 160 nanometer trenches shows deposited nickel completely filling the features without voids

Applications

- **Microelectromechanical**
  These new techniques have many potential applications in the MEMS field including information storage devices and silicide contacts.
- **Magnetic materials**
  This deposition process can be used in the production of magnetic recording media and heads; magnetic sensors, actuators, motors for MEMS devices; and memory devices (MRAM) and bio-medical systems.

Advantages

- **Novel sensors**
  This process of deposition can enable new types of sensors and MEMS devices.
- **3D nanostructures**
  This process is capable of constructing both isolated and interconnected 3D nanostructures that are compatible with semiconductor manufacturing standards.

Abstract

Superconformat Metal Deposition Using Derivitized Substrates: Docket # 02-011

The process of this invention involves first adsorbing a catalyst on the surface of a specimen by immersion in a catalyst-containing solution, followed by electrolytic deposition in a second solution that need not contain catalyst. This two-step superconformal process produces a seam-free and void-free metal microelectronic conductor.

Towards Industrial Scale-Fabrication of Nanowire-Based Devices: Docket # 08-001

The invention deals with the challenge of void-free filling of recessed surface features on non-planar metalized surfaces with iron group magnetic materials. Specifically, the addition of certain benzimidazole derivatives to a conventional additive-free nickel plating baths, e.g. Watts bath NiS04-NiCli, results in a superconformal deposition growth mode. By superconformal deposition we mean that metal deposition occurs preferentially in recessed surface features, such as patterned trenches and vias, thereby resulting in void-free filling. By appropriate patterning and design a variety of fully consolidated 3-D shapes and geometries can be fabricated. The resulting structures have potential use as micromagnets for microelectromechanical devices as well as active magnetic material components for use in a variety of information storage devices. The process may also be

useful in the deposition of Ni and related metals as a precursor to forming silcide contacts in microelectronics.

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Citations

1. NIST Docket 02-011, U.S. Patent # 7,429,401, Superconformal metal deposition using derivatized substrates.
2. T.P. Moffat, D. Wheeler, and D. Josell. Electrodeposition of copper in the SPS-PEG-Cl additive system I. Kinetic measurements: Influence of SPS. Journal of The Electrochemical Society, 151 (4), pp. C262-C271, 2004.
3. B.C. Baker, C. Witt, D. Wheeler, D. Josell, and T.P. Moffat. Superconformal silver deposition using KSeCN derivatized substrates. Electrochemical and Solid-State Letters, 6 (5), pp. C67-C69, 2003.
4. C.H. Lee, J.E. Bonevich, J.E. Davies, and T.P. Moffat, Superconformal electrodeposition of Co and Co–Fe alloys using 2-mercapto-5-benzimidazolesulfonic acid. Journal of The Electrochemical Society, 156 (8), pp. D301-D309, 2009.

Related Items

- Article: New Process Creates 3D Nanostructures with Magnetic Materials
- Article: Ultrathin Wires Made Defect Free

References

- NIST Docket 08-001 U.S. Patent Application #20090188805 file date 01-23-2009

Status of Availability

available for licensing

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